REPORT

OF

THE COMMISSIONERS

APPOINTED TO SUPERINTEND

THE

CONSTRUCTION OF NEW PARLIAMENTARY STANDARDS

OF

LENGTH AND WEIGHT.

Presented to both Houses of Parliament by Command of Her Majesty.

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1854.

TREASURY MINUTE, dated 20th June 1843.

My Lords read the Report of the Commissioners for the restoration of the Standards of Weight and Measure, presented to both Houses of Parliament in 1841, and advert more particularly to the recommendation of the Commission, that a committee of scientific men should be appointed to superintend the construction of the new Parliamentary Standards.

It appears to my Lords to be very desirable that the gentlemen who acted as Commissioners for the Restoration of the Standards should afford their assistance, if they can be prevailed upon to do so, in directing the executive measures necessary for carrying out the recommendations contained in the report now before my Lords.

Their Lordships therefore deem it expedient to propose to the undermentioned noblemen and gentlemen to undertake the task; viz.,

The Astronomer Royal,
Marquis of Northampton,
The Lord Wrottesley,
F. Baily, Esq.,
J. E. D. Bethune,
J. G. S. Lefevre, Esq.,
Sir J. W. Lubbock, Bart.,
The Rev. G. Peacock, Dean of Ely,
The Rev. R. Sheepshanks,
Sir J. F. W. Herschel, Bart., and
Professor Miller.

(The name of the Earl of Rosse was subsequently added.)

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Report of the Committee appointed to superintend the Construction of the new Parliamentary Standards of Length and Weight.

The Committee appointed by minute of the Lords Commissioners of Her Majesty's Treasury, dated 1843, June 20, to superintend the construction of the new Parliamentary Standards of Length and Weight, have the honour to offer the following report :—

Selection of Members of the Committee for direct Superintendence of the Construction of Standards.

1. We held our first meeting on 1843, July 11, when we were informed through our chairman, that, at the request of the First Lord of the Treasury, the construction of the Standard of Length had been undertaken by Francis Baily, Esq., and that of Weight by Professor W. H. Miller. We had the highest satisfaction in recognizing the fitness of these gentlemen, by their talents, their knowledge of the subjects, and their habitual accuracy, to undertake the tasks assigned to them. Mr. Baily had made considerable progress in examining the existing representatives of the former Standard of Length, and in experimenting on the material proper for new standards, when his illness and death suspended for a time all progress in that department. With great pleasure we learned that, at our suggestion (in the first instance), and at the invitation of the Lords Commissioners of Her Majesty's Treasury, the Rev. Richard Sheepshanks had undertaken the construction of the Standards of Length. The actual work of forming the Standards of Length and Weight has accordingly been brought to its termination by Mr. Sheepshanks and Professor Miller.

Materials for Restoration of the Values of the old Standards.

2. By the authority of the Lords Commissioners of the Treasury, and the good offices of Her Majesty's Secretary of State for the Foreign Department with foreign governments, and by the courtesy of scientific societies and private persons, the following standard length-scales and weights were placed at our service :

Length-scales which had been compared with the lost Imperial yard Standard.

Two three-feet iron bars belonging to the Department of the Ordnance Survey.
Shuckburgh's scale, in the possession of the Royal Society.
The brass scale of the Royal Society, No. 46.
The brass tubular scale of the Royal Astronomical Society.

Weights which had been compared with the lost Imperial Troy pound Standard.

The brass Troy pound of the Exchequer Office.
The brass Troy pounds from the cities of London, Edinburgh, and Dublin.
The platinum Troy pound and the two brass Troy pounds then in the custody of Professor Schumacher.
The platinum Troy pound of the Royal Society, No. 48.

3. We have also had access to other length-scales and weights, which were not available for absolute restoration of the values of the lost standards, but which we have thought it desirable to examine, as illustrating the construction of the lost standards. Such are,—

The ruined Imperial Yard Standard (in the custody of the Right Honourable the Speaker of the House of Commons).

Troughton's five-feet scale (presented by W. Simms, Esq., and now preserved at the Royal Observatory, Greenwich).

Ramsden's twenty-feet bar, and Roy's three-feet bar (purchased by the Committee, and now deposited at the Royal Observatory, Greenwich).

Two Troy pounds, formerly in the possession of Mr. Bingley (of which one, late in the possession of Stansby Alchorne, Esq., of the Royal Mint, has been purchased by the Committee).

The Troy pound used by the late Mr. Robinson of Devonshire Street, Portland Place (purchased by the Committee).

The Troy pound formerly belonging to Mr. Freeman (now the property of Messrs. Vandome and Titford).

Construction of the Standard of Length.

4. In regard to the linear measure to be represented by the Standard of Length, we see no reason to depart from the decision in the Report of 1841, December 21, Article 19, to adopt the length of One Yard.

5. The first important question which was left open to us by Article 20 of the same Report, was whether the measure of length should be defined by the whole length of a bar, or by the distance between two points or lines marked on it; and to this question we gave our early and careful consideration.

6. The most celebrated of the standards constructed in modern times is the new Prussian Standard, made by the late astronomer, Bessel. In this standard, the whole length of the bar is adopted as the measure of length. The reasons which induced Bessel to substitute a standard of this construction (or standard *à bouts*) for the standard in which the measure is defined by the distance between points or lines upon its surface (or standard *à traits*), which was the principle of construction of the former Prussian Standard, are explained in page 7 of the Introduction to Bessel's account of the construction of the new Prussian Standard (*Darstellung der Untersuchungen und Maassregeln, welche in den Jahren* 1835 *bis* 1838 *durch die Einheit des Preussischen Längenmaasses veranlasst worden sind, von F. W. Bessel*, Berlin 1839). The first of these reasons is, that if a flexible bar be supported on two points, the extreme length of the bar from the centre of one end to the centre of the other end is not sensibly altered by its flexure, but the distance between two points or lines upon the upper surface may be considerably altered. Bessel has himself, however, remarked, that this objection to line-measure is removed if the lines be engraved on surfaces which are depressed to the middle of the thickness of the bar (a principle long since employed in English standard bars); and, moreover, the tendency to alter the apparent length, whether at the surface or at the middle of the thickness, may be destroyed by proper adjustment of the points of support, and perhaps still more surely by supporting the bar at numerous points by lever-frames which will insure equal supporting forces at all the points (a construction of which the theory has been treated by one of the members of the Committee), or in special experiments, by floating the bar in quicksilver. A second reason assigned by Bessel is, that the principle of end-measure is more convenient than the line-measure for the production (that is, practically, the comparison,) of copies of the standard. It appears probable that this remark is well founded, as regards the construction of secondary standards for commercial purposes, but it is doubtful whether it applies to secondary standards for scientific purposes, and it can scarcely apply to primary standards, in regard to which the consideration of convenience (in the few comparisons that may be made at intervals of many years) has no weight, when contrasted with the consideration of conservation of the standard length. Another reason is, that it is more convenient for use; but the members of the Committee, who have witnessed the operation of measuring a geodetic base

by means of bars carrying the line-measure, have been led to form a high estimate of the convenience of the line-principle in that instance. It would appear, too, that in Captain Kater's measurement of the pendulum, and Mr. Baily's comparisons of the mètre *à traits* with the yard, no inconvenience from that cause was found by either observer. It is moreover to be remarked, that the whole of the British geodetic bases have been measured by bars constructed on the line-principle; and a standard which is intended to apply advantageously to them must be constructed on the same principle. The end-measure has never, so far as we know, been applied to any scientific determination in England.

7. The construction of the ends of a standard formed on the end-principle (which must be made of materials harder than the rest of the bar, so mounted as to admit of a slight adjustment,) is, in Bessel's construction, complicated and unsatisfactory; that of the ends of a standard on the line-principle is simple. The tendency of an end-standard to alter its length by wearing is in only one direction; that of a line-standard, so far as change can be conjectured, is matter of chance; it will however be practically invariable.

8. A single comparison by end-measure is perhaps more accurate than a single comparison by line-measure. On the other hand, it seems doubtful whether this accuracy may not be impaired by the immersion in fluid which has been thought necessary for preventing unequal expansion. There has also been recognized in the line-measures which have been made in the course of these observations, a personal equation different with different observers; but this was only discovered after most of the observations were made. We have no evidence whether such equation exists in comparisons by end-measure, as the whole of the comparisons for the Prussian Standard were made by Bessel himself. Still it is scarcely doubted that in this respect the system of end-measures has an advantage. On the other hand, there is no doubt that, by repeating the measures, and by varying the observers, the errors in line-measures arising from recognized causes will be eliminated, and unexceptionable accuracy will be given to the results.

9. After consideration of all these points, as far as they were known at the time; remarking, in particular, the freedom of a line-standard from any tendency to constant wear, the applicability of a line-standard to our geodetic measures, the facility of comparing all other measures of a similar construction with a scale carefully subdivided, the circumstance that there exist no means of reproducing the old standard length but by reference to existing line-measures, and the historical fact that the British standard for many years past has been a line-standard; we decided on adopting a line-standard, or measure *à traits*, for the Parliamentary Standard of Length.

10. The point which next engaged our attention was the material of which the new Standard of Length should be formed. The qualities required in the material are invariability and durability. Already we had had reason to suspect that bars, which have received their form by undergoing while cold the violent mechanical operations of hammering, rolling, or drawing, will not preserve an invariable length; and these suspicions were raised to certainty by Mr. Baily's examination of the standard scale which *primâ facie* appeared to be the most trustworthy representative of the old Imperial Standard, namely, the Royal Astronomical Society's drawn tubular scale. Remarking then, among the fusible metals and alloys, that copper is soft, and is not easily cast; that cast brass is considered unsound until it has been hammered; that gun-metal is easily cast, and may be made (by due proportion of its component metals) pretty hard and elastic, and is free from liability to corrosion; and that cast steel is perfectly manageable: remarking, also, that platinum, although it possesses the advantageous properties of being very durable, and little affected by change of temperature, is inconveniently heavy and soft; but that iron, whether cast or forged, is manageable, and probably invariable: we considered that our choice of materials was practically limited to the following metals and alloys;

Gun metal (in proportions of copper, tin, and zinc to be determined by experiment).
Cast Steel.
Cast Iron.
Forged Iron.

11. A series of experiments was made by Mr. Baily on gun-metal formed of different proportions of the simple metals. It was found at length that an alloy formed in the following proportions,

Copper - - - - - -	16,
Tin - - - - - -	$2\frac{1}{2}$,
Zinc - - - - -	1,

appeared to possess every desirable property. It is hard; it is highly elastic, recovering its form (as to sense) perfectly after every strain, until the weight placed on it is sufficient to break it, when it breaks without bending; it is also strong.

12. In the gun-metal above described, and in cast steel, and in cast or wrought iron, we were satisfied that we possessed materials for an *invariable* measure. In considering the question of *durability* we could not fail to remark that bars of iron or steel are liable to rust; and that there is great danger of injury or even total destruction from this cause if the bars are inaccessible for many years or for centuries, or if, although accessible, they are very rarely examined. We at length decided on adopting, for the material of the Standards of Length, gun-metal composed in the proportions mentioned above.

13. The form adopted for the Standard of Length and for all its copies is that of a solid square bar, 38 inches long and 1 inch square in transverse section. Near to each end a cylindrical hole is sunk (the distance between the centres of the two holes being 36 inches) to the depth of 0·5 inch. At the bottom of this hole is inserted in a smaller hole a gold plug or pin about 0·1 in diameter, and upon the surface of this pin there are cut three fine lines at intervals of about 0·01 inch transverse to the axis of the bar, and two lines at nearly the same interval parallel to the axis of the bar. The measure of length is given by the interval between the middle transversal line at one end and the middle transversal line at the other end; the part of each line which is employed being the point midway between the longitudinal lines. The other transversal lines were used, in the operations of comparison, only for assigning the scales of the micrometers.

14. It was intended that the permanent rest of each bar, after the termination of the comparisons, should be upon a system of eight roller-cylinders, permitting the free thermal expansion of the bars, these rollers being carried by lever-frames, so arranged that the pressure received by each roller is necessarily one-eighth part of the whole weight of the bar, and the distances between the rollers being nearly those which are defined by the theory of the flexure of bars as proper to insure that the measure between two lines (even if cut upon the surface of the bar) shall not be sensibly altered by the flexure of the bar. During the comparisons, however, the bars were floated in quicksilver.

15. Under the direction of Mr. Sheepshanks, and with our approval, the following apparatus was prepared for the comparison of the bars. A massive foundation of masonry was established in the cellar beneath the apartments of the Royal Astronomical Society, in the block of buildings east of the entrance-gateway of Somerset House. Upon one part of this foundation were supported stone piers and transoms, which carried the comparing microscopes. Upon another part there travelled a large carriage, bearing the trough of water which contained the trough of quicksilver in which the bars floated. It is not necessary here to describe the places of the thermometers, the contrivances for illuminating the divisions, &c., more especially as we have reason to hope that the details will be given by Mr. Sheepshanks in a memoir to be presented to the Royal Society. We desire however, confidently to express our

opinion, that no apparatus possessing equal firmness and delicacy with this, or insuring equal immunity from irregular thermal expansion, had ever before been used for the comparison of standards *à traits*.

16. The selection of authorities for the reproduction of the Imperial Standard was a matter of considerable difficulty. A careful collation of all the direct comparisons of different scales with the Imperial Standard, and of cross comparisons between the different scales, presented anomalies which it was impossible to explain. The scale which at a late date had been compared with greater care than any of the others, namely, the scale of the Royal Astronomical Society, was proved by Mr. Baily to have undergone considerable change. This discovery necessarily took away all authority from other scales of a similar construction. The results obtained from Shuckburgh's scale according as Kater's or Baily's measures are followed, are exceedingly discordant. Indeed, Baily himself rejected the result of his own comparisons through Shuckburgh's scale, as being quite incompatible with the result of direct comparisons with the Imperial Standard. After an elaborate examination of all these measures, Mr. Sheepshanks arrived at these conclusions:—First, that no scales ought to be used for restoration of the value of the Imperial Standard, except those which had been compared *directly* with the Imperial Standard. Secondly, that among these the only admissible scales are, the Royal Society's brass scale No. 46., and the two 3-feet iron bars of the Ordnance Department. After examination of the reasons adduced by Mr. Sheepshanks, we assented to these conclusions.

17. The definition of a length, as represented by a standard bar, requires a statement of the temperature at which the standard bar is to be used. It appears, upon examining the amount of the expansion of a metallic bar for a given change of temperature, that the effect of a change of 0°·01 or 0°·02 Fahrenheit is sensible in the measure of the length of a bar; and it was therefore necessary to employ methods of ascertaining the temperature, which should be certain to that degree of accuracy. No thermometer in England, at the time of commencing these experiments, could be trusted to such a nicety. Mr. Sheepshanks, therefore, commenced his labours by forming a system of original thermometers; determining independently the freezing point, the boiling point, and the volume of every section of the tube, of each. This process occupied a considerable time. To these new thermometers the thermometers employed in the former comparisons of the Imperial Standard with the Royal Society's scale and the Ordnance bars were referred, and the comparisons were reduced anew; and the relations between the lengths of the adopted authorities and the Imperial Standard were ascertained with all the accuracy which the comparative rudeness of construction of the Imperial Standard permitted. The thermometers to be used in the details of the new comparisons were also referred to the new thermometers; the thermometrical expansions of the various bars employed for the new standards, or of similar bars, for temperatures not differing materially from 62° Fahrenheit, were ascertained; and the whole of the thermometrical determinations were placed on a satisfactory basis.

18. Very numerous comparisons were made by Mr. Sheepshanks of the adopted authorities with bars which he called "Brass 2." and "Split-plug A," (the division or *trait* in the latter being not a cut on a flat face of metal, but the line produced by forcing two small surfaces of metal into contact, and then cutting by a transversal section through both pieces of metal; the section of the contact-plane then exhibits a delicate line). There were, however, discordances in the latter comparisons which prevented him from giving full confidence to the results. At length a better mode of illuminating the lines was devised, and then the whole of the preceding work was rejected, and new observations were begun. By means of these, the lengths of bars called Bronze 12 and Bronze 28 were determined in relation to the lost Imperial Standard, and the latter was used as a basis of reference for other bars.

19. The Report of 1841 recommended (Article 5) that, besides the legal standard, there should be prepared four copies, to be deposited in places to be

afterwards determined. Mr. Sheepshanks therefore proceeded to make a series of comparisons of Bronze 28 with numerous bars, in order to select from them five bars which, in respect of the distinctness of their engraving, their floating evenly in quicksilver, and their near approach to the length of the lost Imperial Standard, might seem well adapted to be taken as Parliamentary Standard and Parliamentary Copies. When the observations had been carried to an extent which, it was supposed, would be perfectly satisfactory, it appeared that the results of comparison by different observers were sensibly different. An extensive series of new observations by numerous observers was at once commenced. The discussion of these observations showed clearly, as had been suspected before, that there is a difference among the results of different observers far exceeding the uncertainty inferred by the theory of probable errors from the observations of each observer taken separately. Thus, in the comparisons of Bronze 10 with Bronze 28 there is a discordance between the results obtained by Mr. Sheepshanks from 142 sets of observations, and by Mr. William Simms junior from 24 sets of observations, amounting (in ten-millionth parts of an inch) to 198: whereas the probable errors of the two determinations, deduced in the usual way from the observations of each observer separately, are only 15 and 26. In other words, each observer has a personal equation in the microscopic observation of the engraved lines. The existence of discordances of similar character between the astronomical observations of different observers has been long since recognized. The origin of this personal peculiarity is very obscure, but the fact seems to be beyond doubt. There appeared to be no proper method of treating the results but to take the means of the final results of the different observers, giving equal weight to each.

20. The expansions of these bars corresponding to a given change of temperature had been sufficiently determined in the course of the experiments; and it was then judged expedient, instead of stating the difference in the length of the selected bars at the same temperature, to infer the difference of temperature which would cause all to represent the same length, by the application of which it would be possible to assign the specific temperature at which each bar represents precisely the length of one yard. Thus it was found that the length of one yard as given by the lost Imperial Standard is represented with no sensible uncertainty, except in the measures of the Imperial Standard itself, by the following bars, at the temperatures placed opposite to them:

Bronze 19 or No. 1. at 62·00 Fahrenheit.
Bronze 20 or No. 2. at 61·94 „
Bronze 2 or No. 3. at 62·10 „
Bronze 7 or No. 4. at 61·98 „
Bronze 10 or No. 5. at 62·16 „
Bronze 28 or No. 6. at 62·00 „

21. The degrees of temperature for the use of these standards are defined as proportional to the corresponding apparent increase of volume of quicksilver in the thermometer tube; the degree 32° representing the freezing point of water; and the degree 212° representing the temperature of steam under Laplace's standard atmospheric pressure, or the atmospheric pressure corresponding to the following number of inches in the barometric reading reduced to 32° Fahrenheit.

29·9218 + 0·0766 × cosine (2. latitude) + 0·00000179 × height in feet above the sea;

and the degree 62° denoting the temperature which produces in the quicksilver an apparent expansion equal to $\frac{30}{180}$ of the expansion between 32° and 212°; and so in proportion for other degrees.

22. For the details of every kind relating to the evidences for the restoration of the Imperial Standard, to the formation of thermometers, and to the comparison of the new standard-bars, we must refer to the memoir which we expect from Mr. Sheepshanks.

23. We propose that the bar No. 1. be adopted by the legislature as the Parliamentary Standard of One Yard; that Nos. 2, 3, 4, 5, be adopted as

Parliamentary Copies; and that No. 6. be retained by some Officer of the Government for the comparison of other bars, or for other scientific purposes in which reference to the Standard may soon be required. We will advert shortly to the proposed places of deposit of the Standards Nos. 1, 2, 3, 4, 5.

Construction of the Standard of Weight.

24. The first point which required our decision was the choice of metal for the Standard of Weight. We had little hesitation in fixing on platinum as the metal least susceptible of injury from oxidation or other chemical action, or from heat, and as least liable to uncertainty in the results of weighings, on account of its great specific gravity. The comparative softness of the metal makes it unfit for a standard which will be frequently used; but, when touched with the care that may be expected in occasional comparisons of a National Standard, it is not liable to injury.

25. The form recommended by Professor Miller, and adopted by us, is that of a cylinder nearly 1·35 inch in height and 1·15 inch in diameter, with a groove or channel round it whose middle is about 0·34 inch below the top of the cylinder, for insertion of the points of the ivory fork by which it is to be lifted. The edges are carefully rounded off.

26. For the comparison of weights, Professor Miller procured from Mr. Barrow a balance of the utmost delicacy. This instrument was mounted in a cellar beneath the Mineralogical Museum at Cambridge, and there all the operations of weighing the representatives of the lost Standard, the New Primary Standard, and the copy of the French Standard, were performed.

27. We decided that the weight of the new Standard should be adjusted to correspond (in the proper proportion) to that of the old Troy Standard, on the supposition that both are weighed in vacuo. This understanding is the same which had been adopted by Professor Schumacher and other accurate observers. In order to carry it out fully, it became necessary to decide on the specific gravity of the lost Troy Standard. Upon this element there is some uncertainty. The specific gravity of Vandome's pound at 18° centigrade was found, by weighing in water, to be 8·1505; and this was adopted by Professor Miller as the probable specific gravity of the lost pound, inasmuch as the form of this pound appeared to be very similar to that of the lost Standard, as represented in drawings. The specific gravities of Mr. Bingley's pounds were found by the stereometer to be 8·427, 8·358. That of Alchorne's pound (supposed to be the same as Mr. Bingley's second pound), as ascertained by weighing in water, appears to be nearly 8·375. We received from the late Mr. J. E. Drinkwater Bethune, one of the members of this Committee, a copy of the Bill (as amended in Committee of the House of Commons) which was brought in by Lord Carysfort to give effect to the recommendations of the Committee of the House of Commons of which he had been chairman in 1758, but which from some accidental Parliamentary circumstance did not pass into law; and in this Bill the Troy pound, which it was proposed to legalize as the standard, and which appears to have been the same which was afterwards made the Legal Standard, is described as a piece of "fine copper." It was also remarked by Captain Von Nehus and Mr. Robinson that the standard had the appearance of copper. The specified gravity of the lost Troy pound in that case was about 8·895. No other Standard weight, however, has been found in this or in any other country, whose specific gravity approaches to this value. We have thought it necessary to indicate this uncertainty as carrying with it a slight uncertainty as to the weight which ought to be given to the new standard in order to represent proportionally) the weight of the lost Troy pound in vacuo.

28. We desire at the same time explicitly to remark that the doubt on the specific gravity of the lost standard leaves no uncertainty whatever on its weight when the weighings are performed in air, or on what may be called the commercial weight of the lost standard. The comparisons of the lost standard with existing Troy pounds were necessarily made in air, and no knowledge of

the specific gravity was required for inferring the equality or the amount of difference between them as weighed in air. The same remark applies to the comparisons which have been made between the existing Troy Pounds and the new Standards; and to those which may be made between the new Standards and the weights used in commerce, and between these weights and the precious substances to be weighed with them.

29. Of the eight Troy pounds in our hands which had been compared with the lost Troy Standard, four brass pounds had been compared by Captain Kater in 1824, and two brass pounds and two platinum pounds had been compared by Captain Von Nehus in 1828. A repetition of the comparisons among themselves of the pounds in each group left no doubt that the brass pounds had gained in weight (one excepted, from which a small piece of wood was detached which apparently had been weighed with it), while the platinum pounds retained precisely the same relation as before. There appeared to be no doubt that the increase of weight of the brass pounds arose from oxidation. Professor Miller therefore decided, with our approval, to base his restoration of the standard pound on the platinum pounds only. A Troy pound was accordingly prepared, by the use of these platinum pounds, representing (with a very small assigned error) the weight of the lost Standard in air.

30. In the Report of 1841, Article 25, it was recommended that the future Standard of Weight should be the avoirdupois pound or Pound Weight of 7,000 grains; and it was understood by us that this recommendation was adopted by the Government. The following auxiliary weights were therefore prepared by Professor Miller:—

4 of 1,240 grains each (nearly).
1 of 800.
1 of 440.
1 of 360
4 of 80.
2 of 40.

These weights were so chosen that the larger weights can be compared with combinations of the smaller (thus 80 grains may be compared with twice 40, 360 with four times 80 and one 40, and so on), and that the weight of 5,760 grains can be compared with four of 1,240 and one of 800, and that of 7,000 grains with 5,760 and one of 1,240.

Expressing the error in the 40-grain weight by an algebraical symbol, the error of every weight in this series is determined from comparisons of the weights, and is expressed by two terms, of which one is numerical, and the other is a multiple of that symbol; and the error of $4\times1240+800$ is also expressible by a numerical term and a different multiple of the same symbol. These weights being compared with the Troy pound of 5,760 grains, the value of the symbol was obtained, and therefore the error of any of the 1,240 grain weights was known; and then a pound of 7,000 grains was formed by adding the Troy pound and a weight of 1,240 grains.

31. Five platinum pounds were thus prepared by Professor Miller, marked respectively P S 1844 1 lb, N° 1 P C 1844 1 lb, N° 2 P C 1844 1 lb, N° 3 P C 1844 1 lb, N° 4 P C 1844 1 lb, the specific gravities of which were found to be as follows:

P S	21·15702.
N° 1 P C	21·16634.
N° 2 P C	21·16334.
N° 3 P C	21·16128.
N° 4 P C	21·15549.

Comparing P S with the representative of the Troy pound in the manner just described, it was found that in air of the temperature 65°·66 Fahrenheit, under the pressure of 29·750 inches of mercury (these being the means of the temperatures and pressures at which Von Nehus compared the ancient Troy Standard with the two platinum pounds),

$$\text{P S} = 0{\cdot}6341 \text{ grain} + \frac{7000}{5760} \times \text{lost Standard},$$

and this may be considered as the commercial weight of P S.

Assuming the specific gravity of the lost Standard to be the same as that of Vandome, and that P S and the lost Standard are compared in vacuo,

P S = 7000·000238 grains, of which the lost Standard contained 5760. This may be considered as the philosophical weight of P S.

Also,

N° 1 P C = P S + 0·00052 grains.
N° 2 P C = P S − 0·00088 „
N° 3 P C = P S − 0·00178 „
N° 4 P C P S − 0·00314 „

We recommend that P S be adopted as the PARLIAMENTARY STANDARD OF ONE POUND, and that N° 1 P C, N° 2 P C, N° 3 P C, N° 4 P C, be adopted as Parliamentary Copies.

Places of Deposit of the Standards.

32. It appears from the copy of the Bill of 1758, to which reference has been made, that the custody of the standards by the Clerk of the House of Commons, which continued to the time of the destruction of the Houses of Parliament, was a matter of accident. It is recited in that Bill that the bar and the metallic weight, which it is proposed to adopt as legal standards (and which are described with sufficient accuracy to insure their identity with the late Imperial Standards), together with their duplicates, are in the custody of the Clerk of the House of Commons; and it proposes to enact that "the said "standard Troy pound and the said standard yard shall on or before the "9th September 1765 be deposited and for ever remain in the Court of the "Receipt of the Exchequer, and be there safely kept under the seals of "the Chancellor of the Exchequer and of the Chief Baron, and the Seal "of Office of the Chamberlains of the Exchequer, which seals shall not at "any time be opened but by the order and in the personal presence of the "Chancellor of the Exchequer and the Chief Baron for the Time being, and "then for the purposes only of guarding the same from all damage or injury, "or of inspecting, examining, and comparing the copies and models hereinafter described, &c." The Bill afterwards provides for the appointment of four commissioners, with clerks, workmen, &c., and for the establishment of a proper office; and that "as soon as the said office shall be fixed and established, the said copies of the said standard yard and the said standard "Troy pound, and the said models of parts and multiples, &c., shall be "delivered to the said commissioners by the Clerk of the House of Commons, &c., and that one set shall be kept in the office under the seal of "the Chief Baron of the Exchequer and the seals of the commissioners, and "the other set shall be used for the purpose of sizing and adjusting, &c." It appears that this subject had engaged the attention of the House of Commons in 1758 and 1759, and that the Bill above mentioned was introduced by Lord Carysfort in 1760, and had passed through committee; but in the pressure of business attending the death of George II., and the succession of George III., and the dissolution of Parliament soon following, it was not carried through all its stages. There appears, however, to be no doubt that the intention of the Committee of the House of Commons may be sufficiently gathered from the language of the Bill as cited above.

33. Remarking this probable intention of the Legislature in the year 1760, and remarking also the evident propriety of placing the National Standards under the care of the Executive, we recommend that the Parliamentary Standards of One Yard and One Pound be deposited in the office of the Exchequer, there to be preserved under such regulations as to Parliament may appear fitting.

34. In selecting places for the preservation of the authentic Copies of the Parliamentary Standards, we have been guided by a consideration of the general fitness of the offices named; by an appreciation of the careful and accurate habits of the persons employed in them; by the limited accessibility to standards preserved in such offices, which it may be presumed will be made available for their legitimate purposes only; and by the occasional utility of accurate standards in verification of the operations to which these offices are

devoted. We have in some measure departed from the recommendation contained in the last clause of Article 11. of the Report of 1841, December 21, in proposing that one set be transferred to the Royal Society of London. In this proposal we have been actuated by the considerations that the character of the Royal Society in every respect fits it for recognition as a depositary of scientific standards; that the first attempt in Britain to obtain an accurate standard of length, and the only attempt to secure a durable standard of weight, were made by that body; that it possesses at present a very valuable collection of standards; and that acknowledgment is due to it for its very important contribution to the means of restoring the value of the lost Standards. We adhere to the recommendation in Article 6. of the Report of 1841, that one set of copies should be imbedded in the masonry of a public building. In the distribution of the different copies, we have been guided by trifling peculiarities in the copies themselves.

35. After careful consideration, we recommend,—

That the copy of Length Standard, No. 2, and the copy of Weight Standard, P C, N° 1, be deposited in the Royal Mint:

That the copy of Length Standard, No. 3, and the copy of Weight Standard, P C, N° 2, be transferred to the Royal Society:

That the copy of Length Standard, No. 5, and the copy of Weight Standard, P C, N° 3, be deposited in the Royal Observatory of Greenwich:

That the copy of Length Standard, No. 4, and the copy of Weight Standard, P C, N° 4, be immured in the cill of the recess on the east side of the Lower Waiting Hall in the New Palace at Westminster.

36. We have to report that, under the sanction of the Lords Commissioners of the Treasury, as conveyed by letter of Sir Charles E. Trevelyan, dated 1853, June 23, and with the permission of the Commissioners of Public Works for immuring one set of standards in the masonry of the New Palace, as conveyed by letter of T. W. Philipps, Esq., dated 1853, March 21, we have deposited the Standards and the several Copies above named in the places specified above.

Comparison of the New Standards with Foreign Standards.

37. We have at present compared only one of our standards with a foreign standard, namely, the Pound Weight with the French Kilogramme.

38. By the liberal permission of the French Government, and with every assistance which could be obtained by the good offices of M. Arago, Professor Miller was enabled to make two most satisfactory series of comparisons with the Kilogramme des Archives. One of these was by direct comparison of British weights and auxiliary weights with the Kilogramme des Archives. The other was by indirect comparison; a platinum kilogramme (purchased for the British Government), as nearly as possible similar to the Kilogramme des Archives, having been compared with the Kilogramme des Archives in weight, and also (by means of the stereometer) in specific gravity, and this British kilogramme being compared with British weights. The results for the weight of the Kilogramme des Archives, in grains of which P S contains 7,000, were,—

By direct comparison - - -	15432·3482.
By indirect comparison - - -	15432·3488.

39. We expect that Professor Miller will shortly be able to communicate in a Memoir to the Royal Society the whole of the particulars of the weighings for the formation of the New Standards of Weight and the comparison with the Kilogramme; and we beg leave to refer to this for many details which it would be inconvenient to exhibit here.

On the question of referring the Values of the Measure and Weight represented by the Standards to natural elements.

40. After due consideration of this question, referring to the reasons explained in Chapter II. of the Report of 1841, December 21, we adhere to the recommendation contained in that chapter, and embodied in Articles 1. and 2. of the same Report, that no reference be made to natural elements for the values represented by the standards.

41. We consider the ascertaining of the earth's dimensions and of the length of the seconds' pendulum in terms of the Standard of Length, and of the weight of a certain volume of water in terms of the Standard of Weight, as philosophical determinations of the highest importance, to the prosecution of which we trust that Her Majesty's Government will always give their most liberal assistance; but we do not urge them on the Government at present as connected with the conservation of standards.

Distribution of Copies of Primary Standards.

42. Adverting to the recommendation in Article 32. of the Report of 1841, we have requested Mr. Sheepshanks and Professor Miller to prepare thirty copies of their respective standards. The copies of the Standard of Length are in all respects similar to the Parliamentary Standard, the form and material being well adapted for the contingencies of a journey; but for the copies of the Standard of Weight we have deemed it inexpedient to use a metal so soft as platinum. After consideration of the remarks in Chapter X. of the Report of 1841, we have adopted for the material of the weights gun-metal coated with gilding by amalgam.

43. We propose for consideration in the first instance the following list of places to which copies of the standards should be sent:

In the British Islands:
- Edinburgh and Dublin.

In the British Dependencies:
- Canada.
- Jamaica.
- Cape Colony.
- New Zealand.
- Australia.
- Van Dieman's Land.
- Presidency of Calcutta.
- Presidency of Bombay.
- Presidency of Madras.

In Foreign Countries:

Portugal.	Bavaria.
Spain.	Switzerland.
France.	Sardinian States.
Belgium.	Papal States.
Holland.	Kingdom of Naples.
Prussia.	Turkey.
Hanover.	Persia.
Sweden.	United States of America.
Denmark.	Brazil.
Russia.	Buenos Ayres.
Austria.	Chili.

Derived Standards à bouts.

44. We have already alluded (Article 6 above) to the value of length-standards *à bouts* for the ordinary uses of commerce; and from the commencement of our labours we have proposed to ourselves the formation of a standard *à bouts* equivalent in length to the Parliamentary Standard *à traits*, as necessary for the completeness of our undertaking. After consideration of

the methods of verifying and using such a standard, we recommend that the metal be steel; and that the ends be hardened steel, or hard stone as quartz or sapphire, or some sufficiently hard and incorrodible material; and that the end surfaces be curved, forming portions of one sphere whose centre is the centre of the bar.

45. At our request Mr. Sheepshanks has made preparations for forming such standards, to be compared with a steel Standard *à traits* whose length has been verified in the usual way by the Standard No. 6. to which reference is made in Article 20 above. We are not yet able to report the completion of these standards.

On the Scale of Multiples and Subdivisions proceeding from the Values of the Primary Standards; and on the Decimal Scale.

46. Before deciding on the values of the Secondary and Derived Standards which ought to be preserved in the Exchequer Office for daily use, we judged it necessary to consider most carefully the scale of multiples and subdivisions of the values of the primary standards which we would recommend to the sanction of the Government. Referring first to chapters VII. VIII. and IX. of the Report of 1841, and the recommendations based thereon, tending to alter the linear measures of the chain and the mile, to diminish the confusion between Avoirdupois weight and Troy weight, and to banish the stone of 14lbs. and the hundred weight of 112 lbs., we have to report that we adopt in their utmost extent the whole of those recommendations. Referring more particularly to chapters V. and VI. which recommend a decimal system of coinage, and a sanction of decimal system of Weights and Measures to a certain extent, we propose with the utmost confidence to carry out these recommendations, and even to advance further, adopting some proposals which have originated with other bodies.

47. We wish to state our opinion that, in reference to Decimal Scale generally, the public mind is very greatly changed; and that the introduction of a decimal system will now be very easy, in respect to many points which a few years ago would have offered great difficulties.

48. We desire next to refer to our letter of 1853, March 26, expressing the hearty wish of every member of the Committee, that measures might be taken at the present favourable opportunity for commencing a coinage on the decimal scale descending from the pound sterling.

49. We advert briefly to the notorious fact, that the Bank of England has spontaneously adopted a decimal scale of multiples and subdivisions of the Troy ounce for weighing gold and silver, in which the Bank has been followed by the Royal Mint, and by bullion dealers in general. A bill to be laid before Parliament for the legalization of this scale was prepared by the Bank of England, and was submitted to us. The bill was approved by us, and having passed through Parliament, has now become law.

50. We are anxious also to call your attention to the circumstance that in the Custom House of London it has been found necessary to adopt a series of weights in the millesimal scale of subdivision of the avoirdupois pound, in order to facilitate the calculations of tare upon ribbons and other goods in numerous small packages, upon which duty is payable on the net weight only.

51. We beg leave to refer to the letter of our Chairman under date of 1853 April 21, proposing that the customs duties which it was then contemplated to levy by the hundred weight of 112 lbs. should be changed into equivalent duties levied by the hundred pound of 100 lbs.; and we remark that under any circumstances this step would be convenient; but that if, as we trust, a decimal coinage shall shortly be established, the convenience would become so striking that the change could not very well be deferred. This measure would almost necessarily imply the adoption in the Custom House of weights

of 10 lbs., 20 lbs., &c., and 100 lbs. (a series which, even without a change of tariff, the officers of that establishment are desirous to introduce;) and we do not doubt that the adoption of these weights by the public would soon become so general that, if they were not already recognized by law, it would speedily be found necessary to pass an Act of Parliament recognizing them. In any case, the recognition of a weight of 10 lbs. is necessary, inasmuch as the legal definition of the gallon measure of capacity is the volume of water which under certain definite circumstances weighs 10 lbs.

52. Remarking that a decimal scale ascending from the pound weight is called for on one side, and a decimal scale descending from it is required on another side, and that thus an entire decimal scale based on the pound weight may be considered as likely to be soon established; remarking also that the decimal subdivisions of the pound weight, down to the one thousandth part, are expressed by integral grains; and conceiving that the co-existence of two decimal systems (based one on the pound weight, and the other on the Troy ounce,) offers very great facility for the abrogation of one, and the complete introduction of the other; we cannot but consider that there is now a prospect of attaining the long-desired simplification of the British system of weights, by the entire suppression of Troy weight; and for this reason (in addition to those founded on the extreme convenience of a decimal scale in any special system of weights) we are anxious that every facility should be given to the introduction of the decimal scale based on the pound weight.

53. On these several considerations are based principally the following recommendations regarding the Secondary and Derived Standards which we would propose to place in the Exchequer, and, as far as need requires, in other local offices.

Secondary and Derived Standards.

54. We recommend that the following Secondary Standards of Length be lodged in the office of Exchequer, for public reference:

A mural standard of 100 feet.
A mural standard of 22 yards, or the land chain.
A mural standard of 20 yards.
A mural standard of 10 feet.
(The best form for each of these will probably be, two steel projections inserted in a wall, and defining the required length by the interval between their inner faces.)
A standard *à traits* of one yard, extended to 40 inches, and divided into inches; with a microscopic apparatus for comparisons.
A standard *à traits* of one foot, decimally divided; with similar apparatus.
A standard *à bouts* of one yard, with a multiplying-lever-apparatus for comparisons.
A standard *à bouts* of five links or 1·1 yard.
Standards *à bouts* of two feet, of one foot, of 0·5 foot or six inches, and of 0·25 foot or three inches, with similar apparatus for comparisons.
A standard *à bouts* of the French Mètre.
A standard *à bouts* of the Prussian Yard.

Mr. Sheepshanks hopes shortly to have the standard *à bouts* of one yard ready for deposit in the Exchequer.

55. We recommend that the following Secondary Standards of Weight be lodged in the Exchequer, in addition to those which are now in that office, for public reference:—

100 lbs., 200 lbs. (if judged necessary.)
10, 20, 30, 40, 50 lbs.
1, 2, 3, 4, 5 lbs.
·1, ·2, ·3, ·4, ·5 lb.
·01, ·02, ·03, ·04, ·05 lb.
·001, ·002, ·003, ·004, ·005 lb.
100, 200, 300, 400, 500, 1,000 grains.
10, 20, 30, 40, 50 grains.
1, 2, 3, 4, 5, 6, 7 grams

Small decimal subdivisions of the grain, for verification of the balances.
100, 200, 300, 400, 500 ounces Troy.
10, 20, 30, 40, 50 ounces.
1, 2, 3, 4, 5 ounces.
·1, ·2, ·3, ·4, ·5 ounce.
·01, ·02, ·03, ·04, ·05 ounce.
c001,**002, ·003, ·004, ·005 ounce.
A copy of the French Kilogramme.

Professor Miller has already taken steps for preparing the 10 lbs. weight, the various Troy weights, and the Kilogramme.

56. In regard to standards of capacity, we see no necessity for departing from the recommendations of the Report of 1841, Article 64, which would provide standards of 9 gallons, 5 gallons, 3 gallons, quart, $\frac{1}{5}$ gallon, pint, in a conical form; and bushel, $\frac{1}{2}$ bushel, peck, gallon, $\frac{1}{2}$ gallon, quart, pint, $\frac{1}{2}$ pint, gill, $\frac{1}{2}$ gill, in a cylindrical form.

General Recommendations applying to the Subject of Standards.

57. In the course of our inquiries as to the demand for standards and the state of the standard offices, we have been very strongly impressed with the inadequacy of the present arrangements to maintain the national standards in a state fit for the public wants, as regards either the sufficiency of number of the Exchequer standards, or the state of preservation of those standards, or the nature of the comparing apparatus and the methods used in their applications, or the provincial dissemination of copies of the standards, or the inspection and occasional comparison of all for the purpose of insuring their accuracy. We see no remedy for this unsatisfactory state of things except in the appointment of a permanent scientific officer; whose business it shall be to keep a constant watch on the state of the primary standards, the secondary Exchequer standards, the local standards, the equipments of the standard offices, the relations of British and foreign standards, and the state of the law generally as applying to standards; and to memorialize the Government from time to time, as occasion may arise, on any of these points.

58. We beg to observe that this recommendation is not new. It was proposed in Lord Carysfort's Bill (to which allusion has already been made) that four commissioners should be appointed, each receiving a salary of 300*l.* per annum, with an establishment of eight clerks and a sufficient number of workmen; and although their duties as described do not *totidem verbis* include the employments stated above, yet it is plain that an establishment of this liberal character was intended to maintain the standard department in a perfectly efficient and reputable state. This Bill having (from the accidental circumstances before mentioned) never passed into law, the appointments never were made, and the management of the standards has fallen entirely into the hands of subordinate officers of the Exchequer. No ordinary means have existed of calling the attention of the Government (except on such occasions as the destruction of the national standards) to the improper condition of the buildings, the instruments, or the provincial standards, or to the extreme impolicy of some of the Exchequer regulations; and to this it is undoubtedly owing that the character of the Exchequer Standard Office is not high, and that its utility is very small.

59. We therefore recommend that a permanent scientific officer be appointed with adequate salary, to undertake the duties described in Article 57.

60. Should the Lords Commissioners of Her Majesty's Treasury be pleased to entertain this proposal, and should it be sanctioned by Parliament, the remaining recommendations of this Committee would merge so completely in the duties of the scientific officer that it would be unnecessary for us to urge them specially on their Lordships' attention. In the meantime we venture to point out the following matters as requiring immediate attention.

61. The Apartments in which the business of the Exchequer Standard Office is now carried on are totally unfit for their purpose. We submit that there ought to be provided at least four rooms, fire-proof and out of the

reach of water, carefully adapted to the following purposes:—1. A place of deposit of accurate standards, British and foreign. 2. A place for accurate comparisons of standards. 3. A place for comparisons of ordinary commercial standards and for public business. 4. An official room for the scientific officer. As the character of the office rose, and its business increased, possibly some extension would become necessary.

62. The Length Standards pressingly require improvement. At present there is but one length (the yard) represented in the Exchequer standards, and the apparatus provided for comparing it is so rude that no engineer or ordinary workman in any trade requiring accurate fittings would place confidence in it.

63. The Balances for weighing ought to be replaced by balances of a more accurate construction. Those now in the Exchequer are antiquated in form and inaccurate in principle. The balances in daily use at the Bank of England are probably ten times as delicate as those in the Exchequer Office.

64. The Weights have not been verified for many years.

65. The Standards of Capacity, and the methods of using them, are on the whole in a better state than the standards of length and weight and the methods employed with them. But the standards of capacity have not been verified for many years.

66. The rude process of Attesting the Comparison of a standard of length or capacity, brought to the office for verification, by an impression made by the blow of a hammer, ought to be discontinued from the present day. The length of a bar is altered by this operation to an extent probably many times greater than the error which could be tolerated in delicate workmanship. No London instrument-maker, and no first-rate engineer, can put any confidence in a yard measure bearing the Exchequer stamp. The effect on a measure of capacity is less injurious, but on this also it is injurious. We have ascertained that there would be no difficulty in engraving, by means of a moveable drill, a verification-mark in any required pattern, and we think that steps ought to be taken immediately for the introduction of some apparatus of this kind.

67. The Indenture issued from the Exchequer on the examination of standards appears to be useless, and the stamp duty upon it is prohibitory against the comparison of standards in general. In our opinion this regulation ought to be at once rescinded.

68. It appears probable that the local standards are generally, even in reference to their lower pretensions to accuracy, in a worse state than the Exchequer standards. Until the Periodical Comparison of local standards is enforced, it will be impossible to pronounce certainly on the magnitude of their errors. The Balances of local inspectors are probably in all cases unfit for the examination of the weights used in sales of bullion. There is a great want of Local Standards, and especially of Mural Standards of Length, in the principal towns.

69. We terminate this Report by inviting the attention of the Lords Commissioners of Her Majesty's Treasury to the recommendations in the Report of 1841, from Chapter X. to the conclusion.

G. B. AIRY, Chairman.
ROSSE.
WROTTESLEY.
JOHN GEORGE SHAW LEFEVRE.
J. W. LUBBOCK.
GEORGE PEACOCK.
R. SHEEPSHANKS.
J. F. W. HERSCHEL.
W. H. MILLER.

March 28th, 1854.

To the Lords Commissioners
of Her Majesty's Treasury.

APPENDIX

TO THE

REPORT of COMMISSIONERS appointed to superintend the Construction of new Parliamentary Standards of Length and Weight;

CONTAINING,—

I. Letter of the Commissioners to the Chancellor of the Exchequer, dated 1853, March 26.

II. Letter of the Chairman of the Commissioners to the Chancellor of the Exchequer accompanying the letter of the Commissioners of 1853, March 26.

III. Letter of the Chairman of the Commissioners to the Chancellor of the Exchequer, dated 1853, April 21, with Schedule of certain Import Duties.

IV. Extracts from the "Report of the Commissioners appointed to consider the steps "to be taken for Restoration of the Standards of Weight and Measure, dated "1841, December 21," including the principal recommendations from Chapter X. to the conclusion, namely, Nos. 52 to 55, and Nos. 70 to 99.

I. Letter of the Commissioners to the Chancellor of the Exchequer, dated 1853, March 26.

Royal Observatory, Greenwich,
1853, March 26.

SIR,

BY a letter which the Chairman of this Committee had the honour of addressing to you under date of March 18, you will have perceived that the Committee are at this time preparing a report on the subject of standards, and that, in connexion with this subject, they have felt it to be their duty to represent that they are strongly impressed with the advantages of a decimal system of coinage.

The members of the committee have since learnt that Her Majesty's Government have in contemplation an immediate coinage of copper to a considerable amount. The Committee have the honour to lay before you their urgent request that, before specific steps are taken in reference to the proposed coinage, the decimal system may be carefully considered. They trust that the result of such consideration would be, that the Government would decide on issuing coins, related to the millesimal subdivision of the pound, and bearing distinct inscriptions stating their values in respect to the pound and in respect to the one-thousandth part of a pound (by whatever name it may be called). They request permission to suggest that coins of the values of $\frac{1}{1000}$, $\frac{2}{1000}$, and $\frac{4}{1000}$ of a pound (differing little from the farthing, halfpenny, and penny), might be extensively used by the public without present inconvenience, while the inscription of their values, as estimated in the decimal scale, would afford the means of shortly introducing that scale throughout the entire system.

The Committee have, &c.

(Signed) G. B. AIRY (Chairman).
ROSSE.
WROTTESLEY.
G. PEACOCK.
J. W. LUBBOCK.
J. G. SHAW LEFEVRE.
R. SHEEPSHANKS.
W. H. MILLER.

The Right Honorable W. E. Gladstone,
&c. &c. &c.

II. Letter of the Chairman of the Commissioners to the Chancellor of the Exchequer, accompanying the Letter of the Commissioners of 1853, March 26.

Royal Observatory, Greenwich,
1853, March 28.

SIR,

IN transmitting to you the enclosed memorial of the Committee for Superintending the Construction of Standards of Length and Weight, I have the honour to remark, that the memorial is signed by every member of the Committee except Sir John Herschel, whose position as confidential Officer of the Government prevents him from taking part in this representation.

I have, &c.
G. B. AIRY.

The Right Honorable W. E. Gladstone,
&c. &c. &c.,
Chancellor of the Exchequer.

III. Letter of the Chairman of the Commissioners to the Chancellor of the Exchequer, dated 1853, April 21, with Schedule of certain Import Duties.

Royal Observatory, Greenwich,
1853, April 21.

SIR,

IN a letter which, on the part of the Committee for Superintending the Construction of National Standards of Length and Weight, I had the honour of addressing to you under date of March 18th, I transmitted the substance of two resolutions of the Committee, which applied to practical measures tending to introduce the decimal scale of weights in all the transactions of Government, and thus tending, ultimately, by a most unexceptionable course, to introduce the decimal scale of weights into general use; an object which the Committee regard as extremely important. The nature of the resolutions to which I have the honour to refer is described in the following paragraphs:—

"15. The first proposal is, that a new tariff should be immediately prepared, equivalent " to the existing tariff, but with duties charged in all cases by the pound or by the " hundred pounds (100 lbs.), not by the hundred-weight (cwt. of 112 lbs.)

"16. The second proposal is, that the weights of 7lbs., 14lbs., 28lbs., 56lbs., now in use " at the Custom-house, should at once be changed for the following weights:—1lb., 2, " 3, 4, 5, 10 lbs., 20, 30, 40, 50, 100 lbs."

2. I have the honour now to remark, that a very favourable opportunity for acting on the former of these proposals is presented by the circumstance of an extensive alteration of the tariff being at this time submitted to Parliament, and, as representing for the present time the Standard Committee, I have the honour to request your consideration of the advantage of substituting duties per 100 lbs. for duties per 112 lbs, in all instances in which duties of the latter class occur in the alterations of the tariff.

3. I have extracted from the list of the proposed alterations all the instances in which duties are specified as to be charged per 112 lbs., and I have converted them into equivalent duties at per 100lbs.; and I inclose a Schedule exhibiting the rates of duty on the latter system of charge.

I have, &c.
G. B. AIRY.

The Right Honorable W. E. Gladstone,
&c. &c. &c.,
Chancellor of the Exchequer.

[Enclosure in letter of Astronomer Royal, Chairman of the Committee for Superintending the Construction of National Standards of Length and Weight, dated 1853, April 21.]

SCHEDULE of DUTIES of CUSTOMS proposed by the Chancellor of the Exchequer to be levied by the hundred-weight of 112 lbs., with the corresponding duties as levied by the hundred pounds weight of 100 lbs.

Name of Article.	Duty per 112 lbs.			Duty per 100 lbs.		
No. 3.	£	s.	d.	£	s.	d.
Butter (not of British possessions)	0	5	0	0	4	6
Cheese (not of British possessions)	0	2	6	0	2	3
Raisins (not of British possessions)	0	10	0	0	8	11
No. 4.						
Almonds, Jordan	0	10	0	0	8	11
Almonds, not Jordan nor bitter	0	10	0	0	8	11
Arrowroot	0	0	4½	0	0	4
Barley, pearled	0	0	4½	0	0	4
Biscuit and bread	0	0	4½	0	0	4
Books, of editions prior to 1801	1	1	0	0	18	9
Books, of editions in or since 1801	1	10	0	1	6	10
Books, in foreign living languages in or since 1801 (Under Treaties of International Copyright.)	1	10	0	1	6	10
Books originally printed in the United Kingdom and re-published in the country of export	0	15	0	0	13	5
Books not originally produced in the United Kingdom	0	15	0	0	13	5
Brass, manufactures of	0	10	0	0	8	11
Bronze, manufactures of	0	10	0	0	8	11
Candles, spermaceti	0	2	4	0	2	1
„ stearine	0	2	4	0	2	1

Schedule of Duties, &c.—*continued.*

Name of Article.	Duty per 112 lbs. £	s.	d.	Duty per 100 lbs. £	s.	d.
Candles, tallow	0	2	4	0	2	1
„ wax	0	2	4	0	2	1
Cassava powder	0	0	4½	0	0	4
Chinaware or porcelain	0	10	0	0	8	11
Coculus Indicus	0	5	0	0	4	6
Copper, manufactures of, and copper plates engraved	0	10	0	0	8	11
Corks, square for rounding	0	4	8	0	4	2
Dates	0	10	0	0	8	11
Earthenware	0	10	0	0	8	11
Glass (flint cut glass, flint coloured glass, fancy ornamental glass)	0	10	0	0	8	11
Iron and steel, wrought	0	5	0	0	4	6
Lead, manufactures of	0	2	0	0	1	9½
Leather, cut into shapes	0	10	0	0	8	11
Liquorice paste, not of British possessions	1	0	0	0	17	10
„ powder, ditto	1	0	0	0	17	10
Maccaroni	0	1	0	0	0	10½
Mustard flour	0	1	6	0	1	4
Nux vomica	0	2	0	0	1	9½
Pewter, manufactures of	0	2	0	0	1	9½
Pimento	0	5	0	0	4	6
Plums, French and prunelles	0	15	0	0	13	5
Plums, dried or preserved, except in sugar	0	15	0	0	13	5
Potato flour	0	0	4½	0	0	4
Powder that will serve the same purpose as starch	0	0	4½	0	0	4
Quassia	0	1	0	0	0	10½
Sago	0	0	4½	0	0	4
Scaleboard	0	1	0	0	0	10½
Semolina	0	0	4½	0	0	4
Soap, hard	0	16	0	0	14	4
„ soft	0	11	0	0	9	10
„ Naples	0	16	0	0	14	4
Spelter or zinc, manufactures of	0	2	0	0	1	9½
Starch	0	0	4½	0	0	4
Starch, gum of	0	0	4½	0	0	4
Tapioca	0	0	4½	0	0	4
Tinfoil	0	10	0	0	8	11
„ manufactures of	0	10	0	0	8	11
Toys, viz., marbles	0	1	0	0	0	10½
Vermicelli	0	1	0	0	0	10½
Washing balls	0	16	0	0	14	4
No. 6.						
Flock for paper stainers	0	7	0	0	6	3
Fig cake	0	15	0	0	13	5
Gutta percha, manufactures of, not moulded	0	5	0	0	4	6
Mandioca flour	0	0	4½	0	0	4
Manna croup	0	0	4½	0	0	4
Stearine	0	1	6	0	1	4
Veneers	0	1	0	0	0	10½

IV. Extracts from the "Report of the Commissioners appointed to consider the steps to "be taken for Restoration of the Standards of Weight and Measure, dated 1841, "December 21," including the principal recommendations from Chapter X. to the conclusion, namely, Nos. 52 to 55, and Nos. 70 to 99.

52. That the only secondary standards which are to be used in Great Britain and Ireland, in the verification and legalizing of local standards, be deposited at the Exchequer, and be denominated the Exchequer Standards.

53. That once in every five years, the Exchequer Standards of the yard and the pound be compared with the Parliamentary Standards, and all the Exchequer Standards be compared among themselves and repaired if found incorrect; the first of such quinquennial comparisons to be made within one year after the passing of the Act.

54. That it be the duty of the Comptroller of the Exchequer to memorialize the Lords Commissioners of Her Majesty's Treasury, at the proper time, for authority to the Warden of the Parliamentary Standards to compare the Exchequer Standards of the yard and the pound with the Parliamentary Standards.

55. That in order to avoid loss of time in the use of the Exchequer Standards during the comparison, two sets of Exchequer Standards be constructed (excepting the Exchequer Standard of 22 yards hereafter mentioned), each to be alternately in the care of the Warden of the Parliamentary Standards, and of the Comptroller of the Exchequer.

70. That a set of Itinerant Standards, consisting of a yard and a pound, be prepared by immediate comparison with the Parliamentary Standards; and that they be accompanied with such multiples and submultiples thereof as may be considered expedient; and also with a standard gallon, and its multiples and submultiples, for the purpose of passing from Colony to Colony and back again to England, in a certain rotation, in order to verify once in every ten years the correctness of Colonial Standards; that on every return to England of such Itinerant Standards, they be compared with the Exchequer Standards; that immediately on such comparison being made, it be the duty of the Comptroller of the Exchequer to memorialize Her Majesty's Secretary of State for the Colonies, to order the said Itinerant Standards to be passed on and duly employed; and that it be also the duty of the Comptroller of the Exchequer, in the event of their loss or injury, to memorialize the Lords Commissioners of Her Majesty's Treasury to order their renewal and comparison with the Parliamentary Standards.

71. We beg to express our opinion of the great advantages which would accrue to the public, if the Honourable East India Company would resolve on extending the benefit of a similar provision to the Indian Presidencies and their dependencies.

72. That the construction and values of local standards, with the exception of the land chain of 22 yards, be generally similar to those of the Exchequer Standards.

73. That the local standards of the land chain consist of not more than 30 pieces each.

74. That the local standards be brought to the Exchequer for verification and remarking, at least once in every five years, (the first time to be within one year after passing of the Act,) otherwise to be insufficient for conviction on charges of use of false weights and measures; and that the local inspector be responsible, under penalty, for omission in forwarding or presenting the local standards for verification at the proper time.

75. That Mural Standards of the principal measures of length (1 foot, 2 feet, 1 yard, 10 feet, and, where practicable, 22 yards, and 100 feet,) be securely fixed in or marked on the wall or floor of some public building, in each of certain principal towns, for public use; and that the local inspector of weights and measures do report at stated times on the condition of these Mural Standards to the municipal or county authorities, who shall be responsible for keeping them in good order; but that these Mural Standards be not valid for conviction on charges of false measures.

76. That the towns in which these Mural Standards are to be fixed be named in the Act of Parliament; and that they include at least every town in which assizes are held, and every town with a population exceeding 10,000 persons; and that Her Majesty be empowered, with the advice of Her Privy Council, to direct the addition of other towns and places to the list.

77. That a set of Local Standards, carefully compared with the Exchequer Standards, be forwarded to each of the Colonies, there to be used as Colonial Central Standards, and that provision be made for the distribution of Colonial Local Standards through the respective Colonies, to be verified therein by comparison with the Colonial Central Standards, and subject to the same regulations, and that such Colonial Central Standards be kept in each Colony in the principal town or metropolis of such Colony, in the office of the Surveyor General, or in custody of some other officer to be appointed by the Governor of the Colony as Warden, who shall be responsible for their safe custody.

78. That the powers of inspectors of weights and measures be extended and explained, so as to enable them to examine and seize for trial before a magistrate, weights, measures, and weighing machines, which they have good reason for supposing to be unjust, without warrant, wherever they are found; and also to enter, for the purpose of such examination, any place where goods are exposed, or kept, or measured, or weighed, for sale or other commercial purpose; and, with special warrant of a magistrate, to enter for such examination into any place whatever.

79. That the system of inspection and registration of weights and measures be organized on a complete and uniform plan throughout the Kingdom, with gradations of officers, to whom the general control of the inspection and registration is to be intrusted. We beg to suggest for the consideration of Government, whether these duties might not be efficiently performed by the Officers of Excise.

80. That the powers of corporate bodies, leet juries, &c., in respect to the stamping of weights and measures be wholly abolished, as being productive of no advantage to themselves, and as being pernicious to the public by the irregularity and insecurity which they produce in the examination of weights and measures. We beg to urge this recommendation as, in our opinion, of very high importance.

81. That no weight or measure be stamped by the local inspector except it express the same denomination of weight or measure as one of the Exchequer Standards.

82. That no unstamped weight or measure be legal for purposes of sale or other commercial transaction; excepting glass vessels, and casks.

83. That every iron weight have only one leaden plug for adjustment, as little larger than the inspector's stamp as may be practically necessary to receive its impression.

84. That every weight be distinctly marked with words or figures denoting the value of the weight it professes to represent.

85. That weights of the Troy ounce and the pennyweight and their multiples be marked with the word "Troy" at length, in addition to the mark denoting the value of the weight.

86. That any mass or parcel of any sort of goods, professing to contain a certain weight of such goods exposed or kept for sale, be subject to the Inspector's examination, and to seizure and fine if found unjust; but that the Inspector's power do not extend to the opening of such parcel, unless on weighing it with its covering, if any, as prepared for delivery, there shall appear ground for supposing it to contain less than its professed weight of the said goods.

87. That instruments for the purpose of weighing (except weigh-bridges) be specially included in the powers of the inspectors as regards examination and seizure as well as fine, if found unjust.

88. That weigh-bridges be liable to examination by the inspectors, and to fine if found unjust.

89. That where it shall be impracticable to ascertain the contents of any vessel by the weight of distilled water which it contains, or by pouring water into it from a standard measure, it be permitted to ascertain the contents by gauging (the gallon being assumed to be 277·274 cubic inches), or by pouring seed into it from a standard measure.

90. That all measures of capacity constructed of wood, stamped after the passing of this Act (not having been previously stamped), be of cylindrical form, with a plain and even bottom.

91. That every measure of capacity made of wood or metal be distinctly marked with words or figures denoting the value of the capacity which it professes to represent.

92. That the wine bottle be recognized as a measure containing one sixth part of the gallon.

93. That, in the examination of measures of length, subdivisions of not less than $\frac{1}{8}$th of a yard be verified.

94. That chains used in the measure of land, consisting of not more than 30 pieces, be examined and stamped by the inspector; and that no person shall be admitted to give evidence in any court of justice of having measured land, after the passing of this Act, with any other than a stamped measure, or a measure which has been compared, on each day on which any part of the measurement has been made, with a stamped measure or with one of the Mural Standards mentioned in Article 75.

95. That every false weight, weighing machine, or measure, in the possession of a tradesman, render him liable to a separate penalty.

96. That the Act of Parliament regulating standards, weights, and measures, do contain a distinct statement in a tabular form of all the denominations of weight and measure recognized by the legislature, and the purposes for which each is recognized, with their value expressed in terms of the units of weight and measure which are adopted for the standards; and that all local and customary use of the denominations therein contained, differing from their meaning as it is there stated, be prohibited by distinct enactment.

97. That every contract be declared void in which the quantity of the matter or thing of which the contract treats, shall be expressed in denominations different from those

proposed to be legalized in such tabular statement, or shall be expressed in any customary weight or measure of any place, district, or market, different therefrom, or according to any usage or mutual understanding between the parties to the said contract; unless in the case of such contract being in writing, the denominations, customary weights or measures, usages, or mutual understandings be expressly defined and explained in th body of the contract, and in the operative clauses thereof, in terms of the said legalize denominations.

98. That the publication of tables of weights, measures, and coins professing to be those actually in use in Great Britain and Ireland at the time of publication, other than those legalized by the Act, be prohibited.

99. That in all contracts in which numbers are specified, such numbers be interpreted according to their true and natural sense, any custom of trade or local or temporary usage notwithstanding: and that in all cases where numbers shall be contracted for under special names, such as the dozen, the score, the gross, &c., such names shall be interpreted according to their general acceptation.

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